MEDICAL PROGRESS:

Acute Appendicitis in Childhood; A Summary of Present Concepts

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INCIDENCE

CHILDREN below the age of 14 years account for almost one-quarter (22.5 per cent) of the overall incidence of acute appendicitis. The disease is relatively rare in infants and young children, increasing rapidly in frequency of occurrence as the child approaches adulthood.[4] Males are affected slightly more often than females.[5,10]

ETIOLOGY

The structure and position of the appendix tend to promote stasis, with frequent formation of concretions, change in pressure-distention relationships, and interference with blood supply. Bacteriologic invasion of the wall of the organ follows.[5,12,14] The infecting organisms vary widely, by far the most frequent being E. coli.[5] Hemolytic and non-hemolytic streptococci are found considerably less often. Oxyuris vermicularis is present in a relatively low percentage of cases. The invading organisms are believed to belong to the normal flora of the colon. There is no direct evidence that a correlation exists between the incidence of acute tonsillitis or other acute upper respiratory infection and acute appendicitis.[5,12] There are certain anatomic factors in children which profoundly modify the course of the disease. The appendiceal wall contains relatively less fibrous tissue and more elastic tissue in children than in adults, causing a tendency toward earlier perforation.[13] The appendix in a child is relatively longer as compared with the size of the peritoneal cavity, the cecum more mobile, and the omentum shorter and thinner, than in the adult, resulting in less efficient localization of the inflammation.[12] The younger the child, the more these factors affect the disease.

DIAGNOSIS

A general rule applicable for diagnosis is that "abdominal pain, vomiting, and slight fever should always be considered as due to acute appendicitis until proved otherwise."[12] Abdominal pain is the most constant symptom, appearing in over 95 per cent of all cases.[5,10,12] In non-perforated acute appendicitis, about two-thirds of the patients localize the pain in the right lower quadrant, the remainder in the peri-umbilical region, or generalized throughout the abdomen. Following perforation, however, less than half exhibit right lower quadrant localization.

Over 80 per cent of children with acute appendicitis vomit.[5,10,12] When nausea and anorexia are included in this symptom complex, the percentage so affected rises considerably.[10] Usually the pain precedes the vomiting, but occasionally the reverse is true, especially in children under four years of age. Constipation is present in 13 to 26 per cent of cases, diarrhea in 8.7 to 16 per cent. About 10 per cent or less have urinary complaints.[5,10,12] Less than one-third of these patients have a history of a previous similar attack.

The rectal temperature is usually between 100° F. and 101° F. in cases of non-perforated acute appendicitis and between 101.5° F. and 103.5° F. after perforation occurs. Maximum tenderness is present in the right lower abdominal quadrant in 76 to 98 per cent of patients.[5,10,12] Rectal tenderness can be elicited in 87 per cent of cases.[5] The rectal examination is of great importance, especially considering the frequent tendency of the appendix in children to be directed downward into the pelvis,[11] thus altering the abdominal signs. Abdominal tenderness and muscle spasm may be diminished or even absent in pelvic appendicitis. Spasm of the right rectus muscle is present in 64 per cent of patients having non-perforated acute appendicitis, this figure rising to 94 per cent following perforation.[5,10,12]

A leukocytosis greater than 10,000 is found in over 90 per cent of cases of acute appendicitis, and an increase in the polymorphonuclear cell ratio in over 95 per cent, assuming the normal relative lymphocytosis of childhood is taken into account.[5,10,12] Urinalysis is important mainly for the estimation of the state of hydration by the degree of acetonuria and for the purpose of ruling out urinary infection. Although, occasionally, erythrocytes may be found in the urine secondary to ureteral irritation due to an adjacent acutely inflamed appendix, no such relationship between pyuria and appendicitis can be demonstrated.[5]

The symptoms and signs of acute appendicitis in children are very similar to those seen in adults, provided they can be correctly elicited. The older the child the less difficult this becomes. In the very young, however, irritability, disturbed sleep, and crying spells may continue for hours before vomiting or refusal of food direct the parents' attention to the abdomen. The consequent delay in hospitalization is an important factor in producing a higher incidence of peritonitis, and therefore the relatively higher

mortality and morbidity in this age group. Once the patient is in the hospital, frequent (hourly or oftener) examinations are necessary until the decision to operate is made or the diagnosis of acute appendicitis discarded. Patience and unhurried gentleness are prerequisites for a successful examination. The abdomen should always be palpated first, before other, more frightening aspects of the procedure are carried out.[12] Special abdominal signs such as rebound or referred tenderness are often difficult to elicit and are, therefore, of less value in children than in adults. In performing the rectal examination the finger should be inserted very slowly to prevent sudden painful dilatation of the anal sphincter. The finger tip should explore the pelvis slowly and gently while an attempt is made to direct the child's attention elsewhere.

When diarrhea is present in acute appendicitis, a pelvic mass, or evidence or peritonitis is usually found.[12] If not, some aid in differential diagnosis may be gained by evaluation of the pain, which is continuous in acute appendicitis and recurrent in acute enteritis. Lower abdominal pain persisting longer than 12 hours should be considered due to appendicitis unless proved otherwise.[7] There is no reliable method to differentiate acute appendicitis from mesenteric adenitis.[1] If the patient has an upper respiratory infection, and a highly febrile onset, mesenteric adenitis may be suspected. If appendicitis cannot be ruled out, however, operation should be performed. Occasionally an appendiceal abscess is palpable (14.2 per cent of cases in one series[10]). Frequently, however, these masses are present but not diagnosed preoperatively.[5]

TREATMENT

The treatment of acute appendicitis in childhood is early appendectomy. To this may be added, "When there is reasonable doubt [as to the diagnosis], operate."[10] This holds true whatever the stage of the disease, since, because of the poor localizing factors of the child's peritoneum, the delayed operation or Ochsner regime produces an increase in overall mortality and in morbidity in terms of prolonged hospitalization.

Preoperatively, a delay sufficient to combat dehydration is advisable, although with the average patient this can be accomplished in the interval during which the laboratory data are being gathered or the operating room prepared. Parenteral sulfonamide and antibiotic therapy may be initiated at this time in the very ill. If general peritonitis is present it is well to institute gastric suction prior to surgery. Open drop ether has proved in most cases a safe and reliable anesthetic.

The McBurney incision is the incision of choice and should be used in uncomplicated acute appendicitis, in perforated appendicitis with general peritonitis, in perforated appendicitis with right lower quadrant abscess and in cases of doubtful diagnosis in which acute appendicitis is most likely. A right rectus muscle splitting or medial muscle retracting incision may be used when a pelvic mass is present

within which the appendix is presumed involved, and in cases of doubtful diagnosis wherein the "odds" are against appendicitis. This incision may also prove advantageous in the occasional case in which perforation has occurred into the omentum, with resulting good localization. If the diagnosis can be made preoperatively, by detection of a moveable mass, the operation may be made "clean" by resection of the involved omentum together with the appendix without disturbing the site of perforation.[10] Drainage, when indicated, in cases of right rectus incision, should be established through a "stab" wound in the McBurney area. A lower mortality is associated with the use of the McBurney incision,[4,10] although there is disagreement upon its advantages in children.[5,12]

In freeing a perforated appendix from surrounding structures, gentle dissection with the suction tip is recommended. The blunt instrument adequately separates the adhesions while carrying off the surrounding purulent debris. The stump of the organ should be inverted when this is possible without endangering surrounding organs or unduly prolonging the operation. One to three grams of sulfanilamide crystals are left within the peritoneal cavity if the appendix has perforated, since it is felt that an effective blood level is rapidly attained in this way. Drainage is advocated in most cases of acute perforated appendicitis in children in spite of the recent trend against this procedure in adults similarly afflicted.[9]

The "anti-localizing" factors of the child's anatomy are important in preventing complete resolution of the peritoneal infection as frequently or quickly as this occurs in adults. Two folded rubber dam drains are used. The larger is placed within the posterior cul-de-sac and led outward adjacent to the parietal pelvic peritoneum, and through the wound (if McBurney) or a "stab" wound in the McBurney area. The smaller drain is placed within the inferior right lumbar gutter, emerging adjacent to the first. To preclude small intestinal obstruction or fecal fistula, neither drain should pass between loops of bowel, nor lie against the appendiceal stump.[12] The removal of the drains is as important as correctly placing them, for a pelvic abscess will frequently follow their premature withdrawal. The lumbar drain should be removed in 48 to 72 hours, at which time the pelvic drain is loosened. When the character of the drainage changes from frankly purulent to mucopurulent (fourth to seventh postoperative day as a rule) shortening at the rate of 2 centimeters daily begins. As the drainage becomes small in amount and mucoid in character, the drain is removed (usually upon the ninth to twelfth postoperative day).

It has been recommended on good authority[2,12] that appendiceal abscesses simply be drained, with removal of the appendix only if it is "easily available." This assumes an "interval" appendectomy at some later date. We feel, however, that an effort should be made to remove the organ at the primary operation and that in most cases this can be done.[9,13] To leave the appendix invites recurrence of the infection prior to the secondary operation, and requires

two anesthesias and two laparotomies to accomplish a single result. With modern antibiotic and chemotherapy, the localizing wall of the abscess need no longer be so meticulously avoided by the operator.

The postoperative treatment of these patients is of great importance. In the uncomplicated case of acute non-perforated appendicitis, adequate oral fluid intake usually occurs from the first postoperative day onward, ambulation may be begun at any time after the first postoperative day, with discharge from the hospital in five to seven days. No antibiotic nor chemotherapy is given. When perforation has occured, particularly with general peritonitis, more vigorous measures must be undertaken. Fowler's position is frequently advocated [5,12] but we feel that the resultant pooling of pus within the pelvis promotes adhesions and intestinal obstruction. The dorsal recumbent position with frequent turning from side to side is recommended instead. Hydration is accomplished intravenously by giving 75 to 90 cubic centimeters of 5 per cent dextrose in 0.85 per cent saline, or 5 per cent dextrose in distilled water per pound per day to children under two years of age, 45 to 60 cubic centimeters per pound per day to those over that age. Care is taken to replace only the sodium chloride lost by the normal metabolism plus the loss incurred with the use of gastric suction. The blood chemistries are closely followed and complete intravenous caloric and amino acid replacement attempted only if the period of gastric suction continues longer than three days. Frequently, transfusions are required during the acute postoperative period, or, later, to hasten convalescence. No transfusion should exceed 10 cubic centimeters per pound of body weight. Gastric suction is used for one to five days postoperatively as indicated to combat distention. Frequent use of the rectal tube is also helpful in this respect. External application of heat to the abdomen is not recommended since, following the increase in intra-abdominal temperature, the gases within the bowel tend to expand, and may cause further pain.

Chemotherapy with divided daily dosage of sodium sulfadiazine, 32.4 to 48.6 mg. (½ to ¾ grain) per pound intravenously or subcutaneously is begun 12 hours postoperatively. The interval allows for the absorption of the introperitoneal sulfanilamide. The dose is increased to 65 mg. (one grain) per pound per day of sulfadiazine when the drug can be taken orally. Antibiotic therapy with penicillin and streptomycin is also employed in the very ill. On the theory that about eight times more penicillin is needed to destroy the staphylococcus or streptococcus in the presence of E. coli than when this invader is absent, large doses of this agent are used.[3] Intramuscular penicillin, 50,000 units every three hours, is given to children under five years of age, the dosage increasing with the age thereafter. Streptomycin is given by intramuscular injections every three hours, the total daily dose being 1 gm. for children under five, increasing with age. This drug is discontinued in from four to eight days, or sooner, depending upon the course of the infection. As strep-

tomycin has become more available, our policy has been to use it more, and penicillin less frequently. The oxygen tent is occasionally of value in the immediate postoperative period. Liberal sedation using barbiturates, codeine, or morphine should be employed during the acute illness.

COMPLICATIONS

The complications of appendicitis most often seen are residual peritoneal abscesses (usually pelvic in location), intestinal obstruction, pneumonia, and wound abscess.[10,12] Since the advent of sulfonamide therapy, both pneumonia and intestinal obstruction have materially decreased in incidence.[10] Wound abscess is preventable by draining the incision to the depth of the peritoneum in all cases wherein there is a question of contamination. When this precaution is taken the complication is rare. Residual pelvic abscesses and intestinal obstruction remain the most frequent complications at the present time, being found in 6.7 per cent and 3.9 per cent of cases respectively.[12] These residual abscesses will almost invariably subside with antibiotic and chemotherapy, although occasionally one will drain spontaneously into the rectum or vagina. Intestinal obstruction usually occurs between the fifth and fourteenth postoperative days. About half the cases respond to gastric or small intestinal suction-decompression and chemotherapy. The remainder require secondary laparotomy and lysis of adhesions. The Miller-Abbott tube is of little value in patients under five years of age due to difficulty in passing the tip through the pylorus.

PROGNOSIS

The mortality in acute appendicitis varies mainly with the age of the patient, the stage of the infection when treatment is started, the presence of other disease, and the type of therapy. The fatality rate from this condition in the United States is 4.5 to 5 per cent, including all age groups.[6] The age variation is illustrated by a crude mortality figure of 17.22 per cent for patients under five years of age, 6.2 per cent in the five to nine year group, and 2.74 per cent in those between nine and fourteen years old.[4] The effect of the stage the disease has reached when operation is performed is shown by a mortality of 0.96 per cent in non-perforated appendicitis as compared with that of 10.76 per cent following perforation.[10] There are two essential factors in children which affect the stage of the disease at operation, and thus the fatality rate. One of these is the anatomic difference in intraperitoneal relationships between the young child and the adult. The second is the delay in operation due chiefly to difficulty in diagnosis. The younger the child, the more heavily do both factors weigh against him. In one series, 80 per cent of children under four years of age had peritonitis at operation as compared with 37 per cent of older children.[5] In another, 3 per cent of appendices had perforated after 12 hours of symptoms, 50 per cent after 24 to 36 hours, 64 per cent after 36 to 48 hours, and 90 per cent after five days.[12] It is by decreasing the delay

prior to operation, especially in the very young, that the fatality rate of this disease can be reduced. That the type of treatment has marked influence upon the mortality can be seen by comparison of present statistics with those prior to the use of sulfonamides, antibiotics, and the preoperative and postoperative care practiced today. In one series,[10] the fatality rate in acute non-perforated appendicitis has fallen from 6.06 per cent during the period between 1924 and 1929, to zero during the interval 1940 to 1944. In another series [12] the mortality in acute appendicitis with perforation was 6.43 per cent prior to 1938, and 2.99 per cent between 1938 and 1944. The overall child fatality rate in this same group decreased from 3.06 per cent (1928-1939) to 1.58 per cent (1939-1945). Each series under discussion included over 500 cases. Perforated appendicitis in patients between the ages of one to four years now accounts for practically the entire mortality.

SUMMARY

1. Children under 14 years of age account for almost one-fourth of the overall incidence of acute appendicitis.

2. Certain anatomic factors of the child's appendix and its relationship to the peritoneal cavity favor relatively early perforation and poor localization of the infection.

3. "Abdominal pain, vomiting, and slight fever should always be considered as due to acute appendicitis until proved otherwise."

4. Principles of treatment recommended are:

a. Operation as soon as possible after the diagnosis is made and the patient adequately prepared;

b. Laparotomy if there is a reasonable doubt as to the diagnosis;

c. The use of the McBurney incision in most instances;

d. Removal of the appendix concurrently with drainage of an appendiceal abscess;

e. Drainage of the abdomen in most cases of acute perforated appendicitis.

5. Refinements of treatment and the addition of chemical and antibiotic therapeutic agents have mate-

rially decreased the fatality rate of acute appendicitis in children.

6. The chief factors affecting the mortality at present are the age of the patient and the delay prior to operation.

7. Practically all the deaths due to this disease in children fall within the group of acute perforated appendicitis between the ages of one and four years.

8. Special effort should be made to expedite the diagnosis in the very young, thus reducing the preoperative delay, and consequently the mortality.

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